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The analytical form of the velocity field induced by a helical vortex filament is well known as Hardin's solution (1982). But the essentially same result had been obtained by a Japanese scientist Kawada in 1936, which predates Hardin by 46 years. This talk exposes Kawada's paper (1939) which provides a comprehensive treatment of induced velocity by helical vortices with application to the propeller theory.

Sandi Kawada was a pioneer of aeronautics engineering in Japan, and played a leading role in opening up this field in Japan. He was born on May 26, 1899 and died on July 16, 1970. Kawada was one of the first graduates, in March 1923, of Department of Aeronautics, Faculty of Engineering, the Imperial University of Tokyo, currently being known as the University of Tokyo. After working in Aviation Laboratory as a part-time employee and in the Japanese Army as an aviation soldier for a few years, he was appointed as associate professor of the Imperial University of Tokyo in 1926, and in parallel, he worked as a researcher in Aviation Laboratory. In 1939, he was promoted to a professor. Kawada widely conducted aerodynamic research with his fields ranging over propeller theory, axial blower, turbo jet and high-speed aerodynamics (sub-sonic, transonic and super-sonic regimes). He committed in building a number of wind tunnels of the first generation in Japan. Among others, he led the Japanese society of aeronautics engineering with his theory of propellers.

Aviation Laboratory was established, as a research institute attached to the Imperial University of Tokyo in 1918. The laboratory, with only a couple of specialists in airplanes, was not active, and, to be worse, its building was collapsed by the Great Kanto earthquake, calamity attacking Tokyo region in 1923. When the Shohwa era began in 1926, Chuzaburou Shiba, the Director of Laboratory, embarked on a project of making an airplane which was able to establish a world record, with a view to publisize the work of the Laboratory, and thereby to convince the laboratory staff of their high ability. This project was launched in the summer of 1931, collecting all the members of Laboratory, and in 1938, their airplane achieved the world record of the longest distance flight. Kawada was a chief researcher responsible for propellers. The next project of the laboratory was a creation of an airplane for commercial flight from Tokyo to New York.

The effort in this direction was suspended with the outbreak of the Second World War in the Pacific in 1941, and the activities of the Japanese aeronautical engineering were completely stopped when Japan surrendered to USA in August 1945. GHQ or GHQ/SCAP (General Headquarters, the Supreme Commander for the Allied Powers) banned the aircraft industry and the related research in Japan for 1945-1953. Kawada waved his route off aeronautics, entered into civil engineering and geophysical fluid mechanics, being featured by environment aspect. In this way, Kawada left the aeronautical engineering and his contribution to the

propeller theory lost its connection to the modern development. Aviation industry was almost extinguished when the research ban in aeronautical engineering was lifted in 1953 when the Japan Society of Aeronautical Science got back together. In 1954, Kawada was elected as the president of the society, and devoted himself to reconstructing the society.

Theodore von Karman (in his selected papers of 2004) recognized Kawada's contribution to the development of the vortex model of the rotor: "The second step in the development constitutes a direct application of the Lanchester-Prandtl ideas to rotating bound vortices representing the propeller blades. Helicoidal vortex sheets now replace the free vortex sheet of the Prandtl's theory. This idea was first carried out mathematically by Sydney Goldstein in his doctor's thesis at Gottingen University. Goldstein became one of the leading aerodynamicists in England … Two Japanese aerodynamicists, Moriya and Kawada, continued the work of Goldstein …"

This talk recollects Kawada's theory of propellers (1939) and its relation with his theory of a helical vortex filament (1936) (Fukumoto, Okulov & Wood 2015).

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